Apprenticeship and Industry Training

Transport Refrigeration Technician

Apprenticeship Course Outline

4102-r.1 (2002)

Government of Alberta

Apprenticeship and Industry Training

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Transport Refrigeration Technician
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Course Outline

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Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding an employer. Employers hire apprentices, pay their wages and provide on-the-job training and work experience. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyperson or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution – usually a college or technical institute.

To become certified journeypersons, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board on the recommendation of Transport Refrigeration Technician Provincial Apprenticeship Committee.

The graduate of the Transport Refrigeration Technician apprenticeship program is a certified journeyperson who will be able:

- to repair, maintain and operate by skill and knowledge gained through training and experience any of the working parts of diesel engines as well as the various components of transport refrigeration equipment used to heat or cool the load
- to use, competently, both hand and power tools in order to carry out repairs according to manufacturer's specifications
- to read and understand work orders, prepare estimates and interpret technical manuals and diagrams
- to write service reports, diagnose the cause of failures and keep service analysis records
- to be familiar with the work in related trades such as Machinist, Heavy Equipment Technician and Welder - outstanding individuals may advance to service representatives or supervisory positions
- to be familiar with and apply all statutes and codes associated with the industry
- to perform assigned tasks in accordance with quality and production standards required by industry

Apprenticeship and Industry Training System

Industry-Driven

Alberta's apprenticeship and industry training system is an industry-driven system that ensures a highly skilled, internationally competitive workforce in more than 50 designated trades and occupations. This workforce supports the economic progress of Alberta and its competitive role in the global market. Industry (employers and employees) establishes training and certification standards and provides direction to the system through an industry committee network and the Alberta Apprenticeship and Industry Training Board. The Alberta government provides the legislative framework and administrative support for the apprenticeship and industry training system.

Alberta Apprenticeship and Industry Training Board

The Alberta Apprenticeship and Industry Training Board provides a leadership role in developing Alberta's highly skilled and trained workforce. The board's primary responsibility is to establish the standards and requirements for training and certification in programs under the Apprenticeship and Industry Training Act. The board also provides advice to the Minister of Advanced Education and Technology on the needs of Alberta's labour market for skilled and trained workers, and the designation of trades and occupations.

The thirteen-member board consists of a chair, eight members representing trades and four members representing other industries. There are equal numbers of employer and employee representatives.

Industry Committee Network

Alberta's apprenticeship and industry training system relies on a network of industry committees, including local and provincial apprenticeship committees in the designated trades, and occupational committees in the designated occupations. The network also includes other committees such as provisional committees that are established before the designation of a new trade or occupation comes into effect. All trade committees are composed of equal numbers of employer and employee representatives. The industry committee network is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the board can set up a local apprenticeship committee. The board appoints equal numbers of employee and employer representatives for terms of up to three years. The committee appoints a member as presiding officer. Local apprenticeship committees:

- monitor apprenticeship programs and the progress of apprentices in their trade, at the local level
- make recommendations to their trade's provincial apprenticeship committee (PAC) about apprenticeship and certification in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- make recommendations to the board about the appointment of members to their trade's PAC
- help settle certain kinds of disagreements between apprentices and their employers
- carry out functions assigned by their trade's PAC or the board

Provincial Apprenticeship Committees (PAC)

The board establishes a provincial apprenticeship committee for each trade. It appoints an equal number of employer and employee representatives, and, on the PAC's recommendation, a presiding officer - each for a maximum of two terms of up to three years. Most PACs have nine members but can have as many as twenty-one. Provincial apprenticeship committees:

- Make recommendations to the board about:
    - standards and requirements for training and certification in their trade
    - courses and examinations in their trade
    - apprenticeship and certification
    - designation of trades and occupations
    - regulations and orders under the Apprenticeship and Industry Training Act
- monitor the activities of local apprenticeship committees in their trade
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- consult with other committees under the Apprenticeship and Industry Training Act about apprenticeship programs, training and certification and facilitate cooperation between different trades and occupations
- consult with organizations, associations and people who have an interest in their trade and with employers and employees in their trade
- may participate in resolving certain disagreements between employers and employees
- carry out functions assigned by the board

Transport Refrigeration Technician PAC Members at the Time of Publication

Mr. B. Noble	Lethbridge .....Presiding Officer
Mr. J. Pente	Calgary.....Employer
Mr. A. Linnington	Calgary.....Employer
Mr. B. Purdy	Calgary.....Employer
Mr. M. Stasiuk	Edmonton.....Employer
Mr. K. Fedun	Calgary.....Employee
Mr. M. Roberts	Edmonton.....Employee
Mr. L. Campbell	Edmonton.....Employee
Mr. J. Nixon	Calgary.....Employee

Alberta Government

Alberta Advanced Education and Technology works with industry, employer and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and employers
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

Technical Institutes and Colleges

The technical institutes and colleges are key participants in Alberta's apprenticeship and industry training system. They work with the board, industry committees and Alberta Advanced Education and Technology to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs. They develop lesson plans from the course outlines established by industry and provide technical training to apprentices.

Apprenticeship Safety

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

Alberta Apprenticeship and Industry Training Board Safety Policy

The Alberta Apprenticeship and Industry Training Board fully supports safe learning and working environments and encourages the teaching of proper safety procedures both within trade specific training and in the workplace.

Trade specific safety training is an integral component of technical training, while ongoing or general non-trade specific safety training remains the responsibility of the employer and the employee as required under workplace health and safety legislation.

Workplace Responsibilities

The employer is responsible for:

- training employees and apprentices in the safe use and operation of equipment
- providing and maintaining safety equipment, protective devices and clothing
- enforcing safe working procedures
- providing safeguards for machinery, equipment and tools
- observing all accident prevention regulations

The employee and apprentice are responsible for:

- working in accordance with the safety regulations pertaining to the job environment
- working in such a way as not to endanger themselves, fellow employees or apprentices

Workplace Health and Safety

A tradesperson is often exposed to more hazards than any other person in the work force and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Workplace Health and Safety (Alberta Employment, Immigration and Industry) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.worksafely.org

Technical Training

Apprenticeship technical training is delivered by the technical institutes and many colleges in the public post-secondary system throughout Alberta. The colleges and institutes are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All training providers place great emphasis on safe technical practices that complement safe workplace practices and help to develop a skilled, safe workforce.

The following institutions deliver Transport Refrigeration Technician apprenticeship technical training:

Southern Alberta Institute of Technology (Main Campus)

Procedures for Recommending Revisions to the Course Outline

Advanced Education and Technology has prepared this course outline in partnership with the Transport Refrigeration Technician Provincial Apprenticeship Committee.

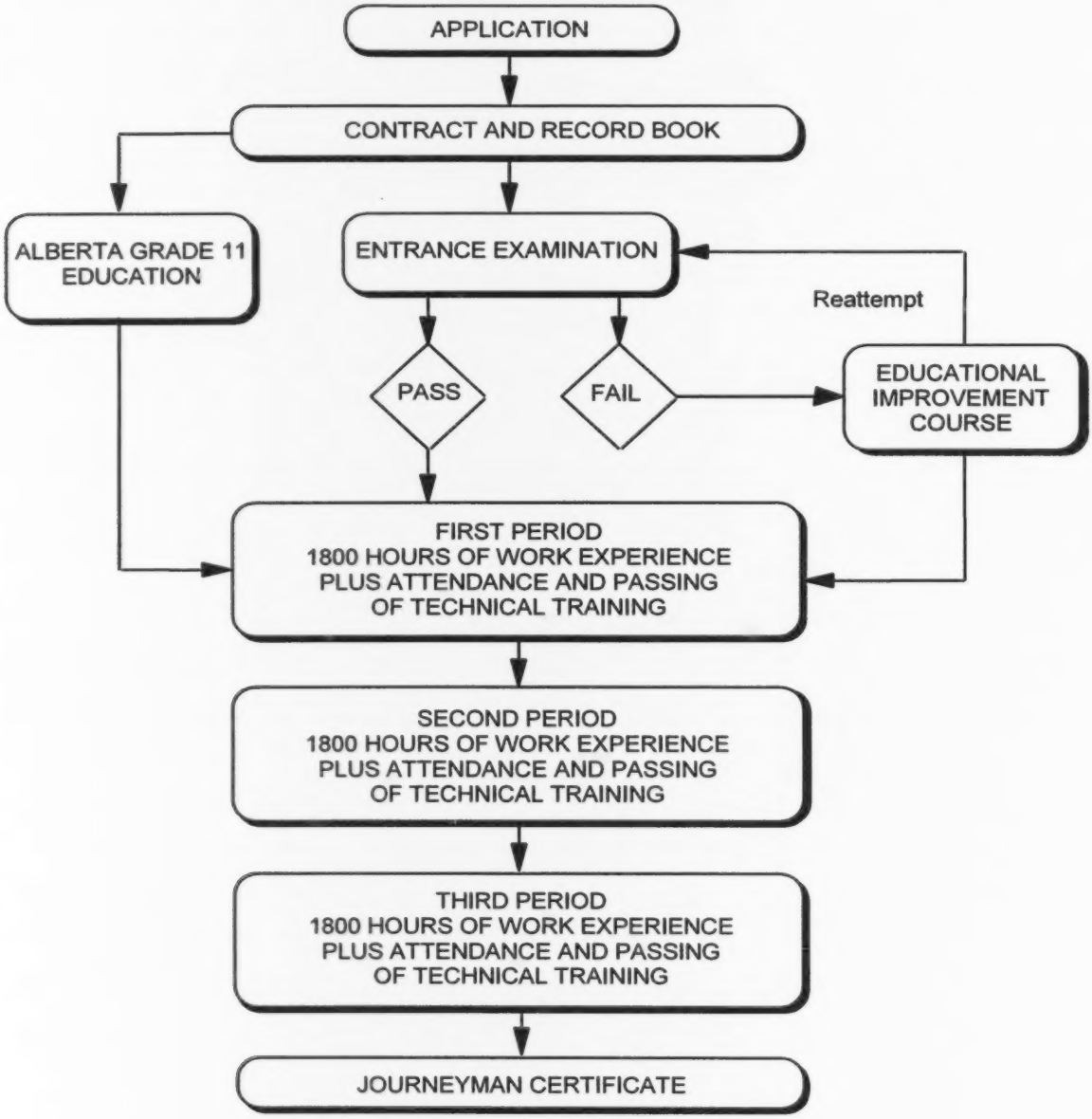
This course outline was approved on September 20, 2002 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

Transport Refrigeration Technician Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
Advanced Education and Technology
10th floor, Commerce Place
10155 102 Street NW
Edmonton AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations for change will be placed on the agenda for regular meetings of the Transport Refrigeration Technician Provincial Apprenticeship Committee.

Apprenticeship Route toward Certification



Transport Refrigeration Technician Training Profile
FIRST PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

REGULATIONS AND SAFETY
0 HOURS

A	B	C
WHMIS 0 Hours	Occupational Health and Safety Regulations 0 Hours	Advisory Network 0 Hours
D	**E**	**F**
Fire Prevention and Controls 0 Hours	Other Concerns 0 Hours	Tools 0 Hours

SECTION TWO

SAFE USE OF OXYACETYLENE EQUIPMENT (FOR SOLDERING AND BRAZING)
21 HOURS

A	B	C
Gases 2 Hours	Cylinders and Fittings 2 Hours	Regulators and Hoses 2 Hours
D	**E**	
The Oxyacetylene Torch 3 Hours	Soldering and Brazing 12 Hours	

SECTION THREE

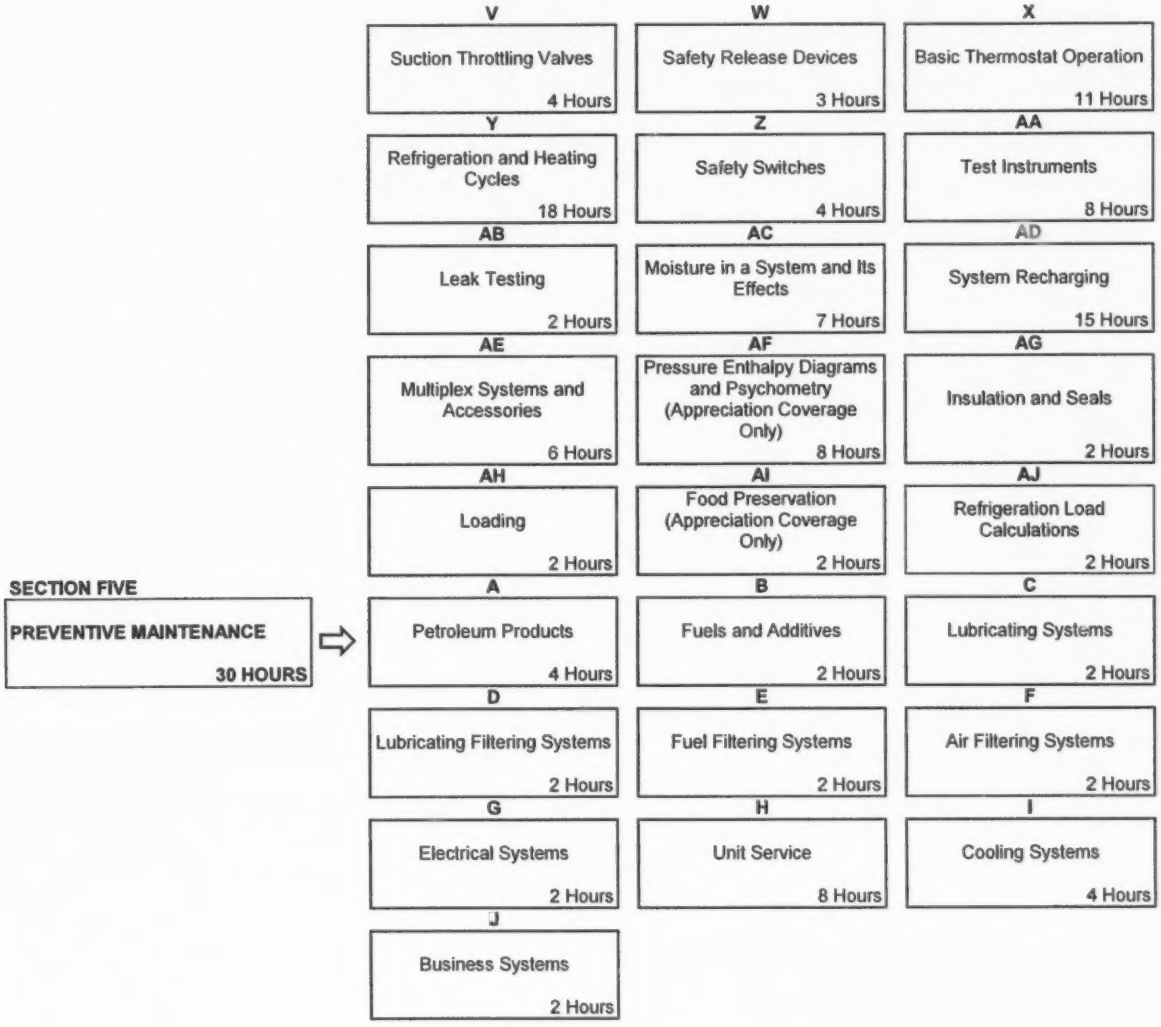
TOOLS, MATERIALS AND FASTENERS
8 HOURS

A	B	C
Hand Tools (Non-Cutting) Including But Not Limited To 0 Hours	Hand Tools (Cutting) Including But Not Limited to Selection, Use and Maintenance of 2 Hours	Hand Tools (Miscellaneous) 2 Hours
D	**E**	**F**
Materials (Metallic) 1 Hour	Materials (Non-Metallic) 1 Hour	Fastening Devices 2 Hours

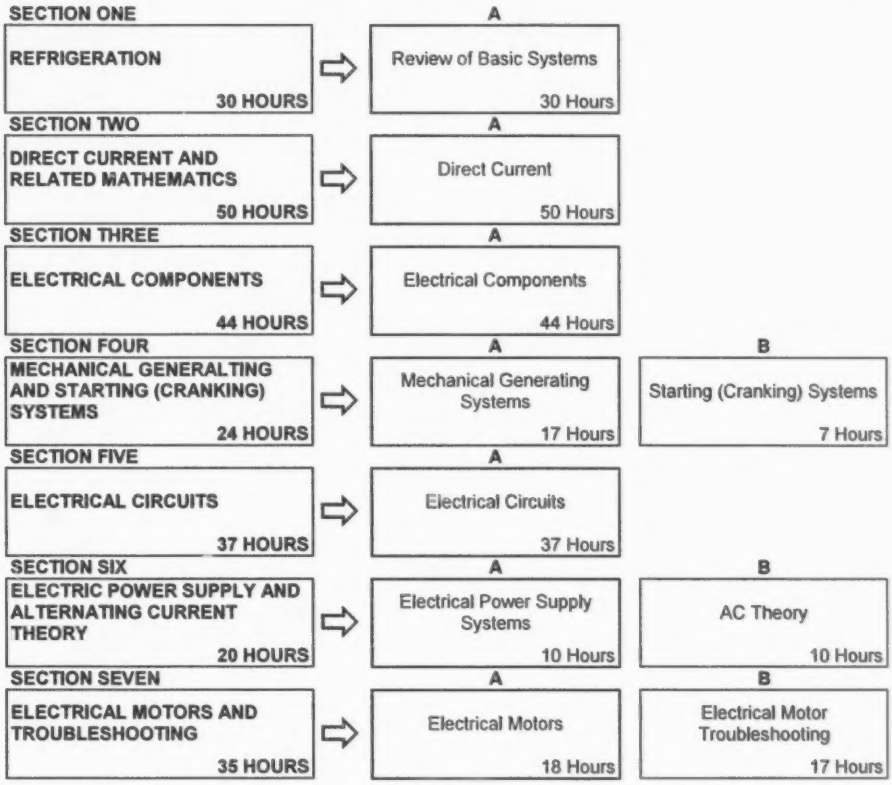
SECTION FOUR

TERMINOLOGY AND REFRIGERATION
181 HOURS

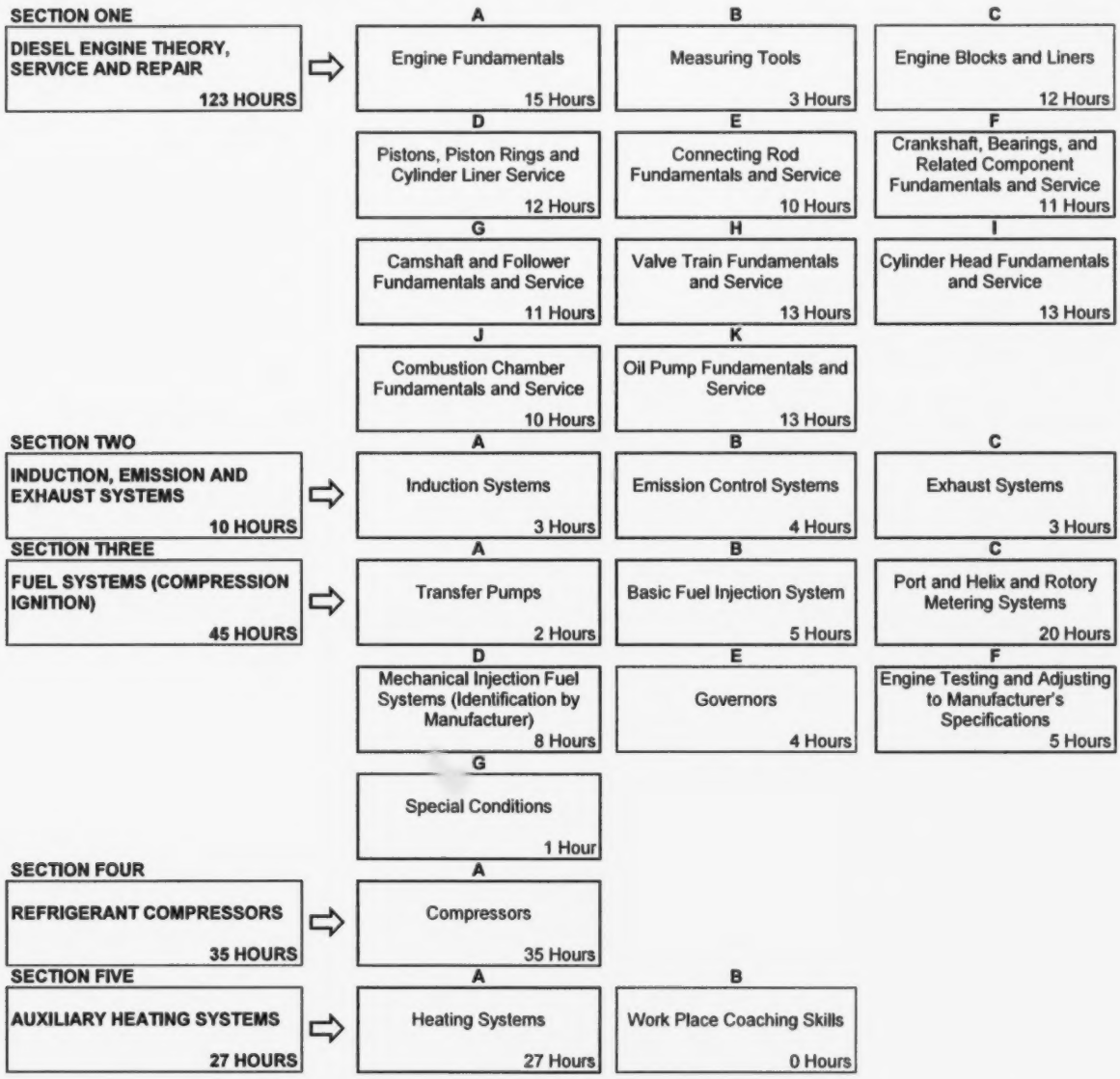
A	B	C
Heat and Temperature 4 Hours	Methods of Heat Transfer 2 Hours	Work, Power and Energy (Imperial and Metric Measurements) 4 Hours
D	**E**	**F**
Refrigeration 1 Hour	Terminology and Calculations 10 Hours	Refrigerants and Oils 10 Hours
G	**H**	**I**
Environment Canada Handling Certificate 8 Hours	Basic Refrigeration Cycle 15 Hours	Compressors 3 Hours
J	**K**	**L**
Control Valves 2 Hours	Condensers 2 Hours	Shutters 1 Hour
M	**N**	**O**
Receivers 2 Hours	Drier-Fitter 2 Hours	Moisture Indicators 1 Hour
P	**Q**	**R**
Heat Exchanger 2 Hours	Refrigerant Metering Devices 10 Hours	Evaporators 2 Hours
S	**T**	**U**
Accumulators 2 Hours	Vibration Absorbers 2 Hours	Service Valves 2 Hours


SECTION FIVE
PREVENTIVE MAINTENANCE
30 HOURS
A
Petroleum Products
4 Hours
B
Fuels and Additives
2 Hours
C
Lubricating Systems
2 Hours
D
Lubricating Filtering Systems
2 Hours
E
Fuel Filtering Systems
2 Hours
F
Air Filtering Systems
2 Hours
G
Electrical Systems
2 Hours
H
Unit Service
8 Hours
I
Cooling Systems
4 Hours
J
Business Systems
2 Hours
V
Suction Throttling Valves
4 Hours
W
Safety Release Devices
3 Hours
X
Basic Thermostat Operation
11 Hours
Y
Refrigeration and Heating Cycles
18 Hours
Z
Safety Switches
4 Hours
AA
Test Instruments
8 Hours
AB
Leak Testing
2 Hours
AC
Moisture in a System and Its Effects
7 Hours
AD
System Recharging
15 Hours
AE
Multiplex Systems and Accessories
6 Hours
AF
Pressure Enthalpy Diagrams and Psychometry (Appreciation Coverage Only)
8 Hours
AG
Insulation and Seals
2 Hours
AH
Loading
2 Hours
AI
Food Preservation (Appreciation Coverage Only)
2 Hours
AJ
Refrigeration Load Calculations
2 Hours

SECOND PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)



THIRD PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)



NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training.

FIRST PERIOD TECHNICAL TRAINING
TRANSPORT REFRIGERATION TECHNICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

Due to the nature of the work of the Transport Refrigeration Technician, it is imperative that safety be taught on a continuous basis throughout the entirety of this course.
Special emphasis should be placed on weak areas of theory and lab that are evident from progressive tests and examinations administered throughout the course. The time required for such examinations and testing shall be allowed for in each area of instruction.

SECTION ONE: ..... REGULATIONS AND SAFETY ..... 0 HOURS

A. WHMIS ..... 0 Hours

1. Introduction to Workplace Hazardous Materials Information System (WHMIS).
2. Describe what WHMIS is, its rational and major elements.
3. Define what a WHMIS label means and distinguish between supplier and workplace labels and other means of identification.
4. Describe what is meant by the following classifications:
   a) prohibited product
   b) restricted product
   c) controlled product
5. Explain what a Material Safety Data Sheet (MSDS) is, its purpose and limitations.
6. Describe the roles and responsibilities of employer, supplier and worker in the education of workers.

B. Occupational Health and Safety Regulations ..... 0 Hours

1. Interpret first aid regulations.
2. Be aware of general accident prevention regulations with emphasis on:
   a) general safety precautions
   b) housekeeping, personal protective equipment, clothing
   c) respiratory protective equipment
   d) confined space entry
   e) electrical wiring and equipment
   f) powerlines
   g) compressed and liquid gas systems
   h) compressed air prohibition, lines and nozzles
   i) refrigerants - hazards and safety precautions
   j) grinding
   k) uses of safeguards
   l) ladders
   m) hoisting units - slings
   n) over filling refrigerant and propane containers

C. Advisory Network ..... 0 Hours

1. Describe/explain the role and purpose of the advisory network and Provincial Apprenticeship Committee for the Transport Refrigeration Technician Trade:
   a) organizational chart

D. Fire Prevention And Controls ..... 0 Hours

1. Identify the types of fires and available extinguishers.
2. Define the critical areas in the industry.
3. Learn how to prevent fires and work in safety:
   a) use of proper waste containers

E. Other Concerns ..... 0 Hours

1. Outline emergency procedures and how to obtain assistance for injured workers.
2. Know the procedure for obtaining first aid training and certification.
3. Describe the following industrial health hazards:
   a) fumes and skin contact with toxic substances
   b) noise
   c) eye protection
   d) exhaust fumes - carbon monoxide

F. Tools ..... 0 Hours

1. List the reasons for and importance of grounding electrical equipment.
2. Describe why electrical equipment must be kept dry and free from loose material.
3. Explain the importance of maintaining power tools, electrical cords and plugs.
4. Describe and demonstrate safe work practices when using impact tools.

SECTION TWO: SAFE USE OF OXYACETYLENE EQUIPMENT (FOR SOLDERING AND BRAZING) 21 HOURS

A. Gases ..... 2 Hours

1. Explain the characteristics, composition, and recommended handling precautions of the following common gases:
   a) oxygen
   b) acetylene
   c) propane

B. Cylinders and Fittings ..... 2 Hours

1. Identify the respective cylinders and fittings by colour, thread design and sizes.
2. Explain the design of the cylinders and how these are to be handled and stored.
3. Explain the Transportation of Dangerous Goods Act as it pertains to the Transport Refrigeration Technician trade:
   a) refrigerants
   b) oxyacetylene
   c) etc.

C. Regulators and Hoses ..... 2 Hours

1. Describe the principle operation of regulators, their operating pressures, safety, maintenance and testing.
2. Identify and describe hoses as to:
   a) colouring
   b) threads
   c) sizing standards
3. Describe the care and handling of hoses.
4. Describe the methods and precautions of detecting leaks in oxyacetylene equipment.

D. The Oxyacetylene Torch ..... 3 Hours

1. List and identify the parts of a torch.
2. List and describe the functions of torch components including tip types and sizes.
3. Describe and demonstrate the correct lighting and extinguishing procedures, the types of flames available and use of each type for oxyacetylene welding and cutting:
   a) carbonizing
   b) neutral
   c) oxidizing
4. Demonstrate the care and storage of a torch and tips including cleaning methods.
5. Explain the following terms, including causes and corrective procedures for:
   a) backfires
   b) flash backs
   c) over heating
   d) incorrect mixtures
   e) shut-down

E. Soldering and Brazing ..... 12 Hours

1. Describe the types and grades of solder and brazing materials used in refrigeration repairs, installations and fabricating including:
   a) silfos
   b) silver brazing
   c) stay brite
   d) 95/5
   e) resin core
2. Demonstrate torch soldering and brazing including:
   a) joint preparation
   b) fluxes
   c) heat applications
   d) clean up
   e) nitrogen

SECTION THREE: ..... TOOLS, MATERIALS AND FASTENERS ..... 8 HOURS

A. Hand Tools (Non-Cutting) Including But Not Limited to.....0 Hours

1. Describe the selection, use and maintenance of hammers, screwdrivers, punches, wrenches, pliers, clamps and vices.
2. Demonstrate proper maintenance and safety precautions of punches and wrenches.
3. Describe the types and sizing of vices, the correct mounting and methods of holding work.
4. Describe the types and uses of soft vice jaws.
5. Describe the selection, use and maintenance of pushers and pullers used in the industry.
6. Demonstrate the safe use of commonly used wire rope slings, synthetic slings, chains, hoists and jacks.
7. Describe the proper care, maintenance, and use of wire and synthetic rope, jacks and hoists.

B. Hand Tools (Cutting) Including but Not Limited to Selection, Use and Maintenance of.....2 Hours

1. Select and install correct blades for a hacksaw (number of teeth) for specific projects.
2. Demonstrate the correct use of hacksaws for cutting different types of material.
3. Describe the types of files according to the size and shape, including:
   a) stance
   b) speed and feed
   c) proper holding
4. Select and use files for specific surfaces:
   a) finished surfaces
   b) shape of work
   c) amount of material to be removed
   d) select, install and care for file handles
5. Select types and sizes of chisels and demonstrate the correct use of each.
6. Describe the variations of hardness in the different areas of a chisel.
7. Demonstrate the correct sharpening and shaping of chisel ends (points and heads).
8. Describe the different types of reamers, their proper use and storage.
9. Demonstrate the use of various reamers for a specified project.
10. Explain how twist drills are classified, reconditioned and selected for common drilling operations.
11. Describe the relationship of lubricants to material to be drilled.
12. Recognize and describe common drilling faults and causes.
13. Demonstrate proper drilling techniques including drilling safety precautions:
    a) drill speed
    b) drill breakthrough
14. Describe the types and applications of taps:
    a) taper, plug, bottoming
15. Recognize thread type and thread characteristics:
    a) pitch, crown, depth, etc.

16. Describe tap and die failures and remedies.
17. Describe the care and storage of taps and dies.
18. Calculate tap drill sizes.
19. Specify correct threading lubricants, procedures and precautions and importance of thread "fit".
20. Describe the types and grades of abrasives - the limitations and safe uses of:
    a) sheet
    b) disc
    c) grinding wheels
    d) cut off wheels
    e) grinding compounds
    f) hone stones

C. Hand Tools (Miscellaneous) ..... 2 Hours

1. Demonstrate the use of stud and bolt removers.
2. Describe the procedures and precautions when using stud and bolt removers.
3. Demonstrate the reconditioning of holes and the installation of:
    a) heli-coils
    b) LAP-Lock, etc.
4. Describe the reasons and procedures for annealing copper tubing.
5. Demonstrate single, double and SI flaring of steel tubing.
6. Recognize copper, steel, plastic and brass tube fittings.
7. Describe and demonstrate tubing repairs.
8. Recognize tube and fitting sizes.
9. Demonstrate the use and care of tube benders and swaging (swedging tools).
10. Demonstrate the use, procedures and precautions of tube pinchers.

D. Materials (Metallic) ..... 1 Hour

1. Recognize the various metals, ferrous and non-ferrous used in the industry:
    a) cast iron
    b) copper
    c) steel
    d) stainless steel
    e) aluminium
    f) brass
2. Identify and state the characteristics of the metals common in the industry and indicate their normal use.
3. Explain the manufacturing process used to form the metals to the desired shape and state the reason for the use of the different processes e.g. new copper tubing techniques for heat transfer.
4. Describe a metal's resistance to heat, ductility, friction, etc. and the results of these and limitations.

5. Define the following terms and indicate the characteristics of different metals associated to the terms:
   a) hardening
   b) annealing
   c) tempering
   d) quenching
   e) drilling
   f) cutting
   g) fusion
6. State the handling and safety techniques when using the metals common to the industry, e.g. uncoiling copper tubing.

E. Materials (Non-Metallic).....1 Hour

1. Identify the use of non-metallic materials used in the manufacture and maintenance of equipment used in the industry:
   a) neoprene
   b) nylon
   c) open and closed cell insulation types
2. State the advantages and safety factors associated with the non-metallic materials common in the manufacture and maintenance of equipment common in the industry.

F. Fastening Devices .....2 Hours

1. Describe types, uses and selection for the following:
   a) bolts
   b) nuts
   c) capscrews
   d) screws
   e) chemical fasteners
2. Describe the types, functions, grades, sizing and threading standards of fasteners S.A.E., S.I. and metric including:
   a) bolts
   b) bolt head designs
   c) bolt grade markings
   d) nuts
      i) plain
      ii) castellated
      iii) slotted
      iv) lock nuts
   e) screws
      i) machine screws and nuts
      ii) set screws
   f) capscrews
   g) locktight
3. Explain the theory of torquing.
4. Demonstrate the torquing patterns, procedures and precautions for a given project.
5. Describe the procedure for removal of seized nuts and broken bolts.

6. Describe the use and function of the following:
    a) flat washers
    b) lock washers
    c) shakeproof washers
7. Identify types and uses for:
    a) woodruff
    b) square
    c) split pins (cotter)
    d) tapered pins
    e) tubular pins
8. Describe the use of pins for fastening and alignment, including:
    a) cotter pin
    b) dowel pin
        i) plain
        ii) threaded
9. Identify and describe the types of keys used in the industry.
10. Describe the installation and removal procedures of keys including the use of special tools.
11. Describe the use of setscrews with keys and keyways.
12. Describe the application and types of automotive rivets used in the industry.
13. Demonstrate the installation and removal procedures of rivets.
14. Describe the types, shapes and functions of locking rings.

SECTION FOUR: .....TERMINOLOGY AND REFRIGERATION.....181 HOURS

A. Heat and Temperature .....4 Hours

1. Define heat and temperature.
2. Define the types of heating including:
    a) sensible
    b) latent
    c) specific
    d) others
3. Identify the fixed points for different temperature measuring scales.
4. List and interpret different temperature scales.
5. Explain and use formulas on how temperatures are converted from one scale to another.
6. Calculate temperatures from Celsius to Fahrenheit and vice versa.
7. Define matter and describe its three basic states:
    a) solid
    b) liquid
    c) gaseous

B. Methods of Heat Transfer.....2 Hours

1. Describe principles and laws of heat transfer.
2. Define the three basic forms of heat transfer.
3. Describe heat flow by each method.

C. Work, Power and Energy (Imperial and Metric Measurements).....4 Hours

1. Define force.
2. List the units of force.
3. Define pressure (gauge and absolute).
4. List the units of pressure (imperial and metric).
5. Measure and calculate pressures using the necessary instruments.
6. Describe pressure effects on a liquid.
7. Calculate pressures using scales and scale conversions.
8. Define the unit of work (Joule) (J).
9. Define the two kinds of energy:
   a) kinetic
   b) potential
10. Solve problems concerning energy.
11. Define power.
12. Solve problems concerning power.
13. Define efficiency.
14. Describe efficiency as it applies to refrigeration:
    a) volumetric efficiency
    b) motor efficiency
15. Define specific gravity and density.
16. Relate gravity and density as they apply to a ratio of water or a gas.

D. Refrigeration.....1 Hour

1. Describe the evolution of refrigeration and its definition.
2. Explain the general background and function of refrigeration as it pertains to the industry for cooling and preservation.

E. Terminology and Calculations.....10 Hours

1. Use a simple calculator to perform functions in imperial and metric conversion:
   a) addition
   b) subtraction
   c) multiplication
   d) division
   e) square root
   f) common fractions

2. Calculate using common fractions related to the trade, including:
   a) proper and improper fractions
   b) adding
   c) subtracting
   d) dividing and multiplying
   e) decimal conversion
3. Explain the meaning of the specific terms and perform the necessary calculations to arrive at unknown quantities in imperial and metric units:
   a) mass
   b) volume
   c) area
   d) force
   e) torque
   f) velocity
   g) temperature
4. Identify and calculate units of linear measurement in the Imperial and SI systems for:
   a) heat
   b) cold
   c) sensible heat
   d) latent heat
   e) super heat
   f) specific heat
   g) British thermal unit
   h) specific volume
   i) density
   j) sublimation
5. Understand the terminology associated with industry and be capable of explaining the meaning of the specific terms used.
6. Demonstrate the procedure used to change a formula to calculate the unknown when adequate facts are available.
7. Identify slang and shop terms and correct with proper terminology.
8. State the value of using proper terminology.

F. Refrigerants and Oils.....10 Hours

1. Explain the purpose and desirable properties of a refrigerant.
2. List the most common refrigerants used in the industry and why the correct refrigerant must be used in a system.
3. Explain the characteristics of the refrigerants common in the industry.
4. Describe hazards and safety precautions when handling and working with refrigerants.
5. Explain the purpose of compressor oil.
6. List viscosities of oil used in the industry.
7. Describe the proper handling and storage of compressor oil.
8. Describe the oil condition when given an oil colour.

9. Describe types of compressor oil:
   a) synthetic base
   b) petroleum base
10. Perform an oil acidity test and describe the purpose of it.
11. Describe compatibility of oil to:
   a) oil (examples of oils)
   b) refrigerant

G. Environment Canada Handling Certificate ..... 8 Hours

1. Describe ozone depletion.
2. Explain the classifications of refrigerants as per code.
3. Classify refrigerant cylinders and testing requirements.
4. Describe density and specific gravity.
5. Describe tank-filling procedures.
6. Describe the responsibilities of technicians working on systems and minimising release of refrigerants:
   a) installing systems
   b) servicing systems
7. Identify the four R's:
   a) Recovery
   b) Reuse
   c) Recycle
   d) Reclaim
8. Describe the meaning of the term "recovery".
9. Describe the methods of recovering refrigerants.
10. Explain the conditions that must be addressed when reusing refrigerants.
11. Explain the procedure to recycle refrigerants.
12. Identify the equipment that is required to recycle.
13. State the method of identifying a container used to hold refrigerant for reclaiming.

H. Basic Refrigeration Cycle ..... 15 Hours

1. Describe the operation of a basic cycle of a refrigeration system.
2. Identify the main components.
3. Identify with the aid of a diagram or unit all the main components in a mechanical refrigeration system and indicate their location and function.
4. Explain the cycle in detail including fundamentals of the system.

I. Compressors ..... 3 Hours

1. Identify the types and principles of operation of compressors used in the industry.
2. Correctly explain the related compressor and design terminology:
   a) compression ratio
   b) net refrigeration effect
   c) required weight of refrigerant
   d) volume of vapour to be pumped
   e) servicing
3. Solve problems involving the related terminology.

J. Control Valves ..... 2 Hours

1. Describe the purpose of control valves used in a system:
   a) 3 way
   b) solenoid control (3 and 4 valve system)
   c) modulation valve
   d) electric throttling valve
2. List three techniques used to control refrigerant flow in a system.
3. Describe operating principles of the valves used in the system.
4. Test and replace faulty valves in a system.

K. Condensers ..... 2 Hours

1. Explain the purpose of the condenser.
2. Describe the construction of condensers.
3. Describe the purpose and function of various types of condensers used in the refrigeration systems including:
   a) air cooled condenser
   b) water cooled condensers
   c) evaporative condensers
4. Diagnose plugged or restricted condensers internally or externally.

L. Shutters ..... 1 Hour

1. Describe the purpose and operation of condenser shutters.
2. Demonstrate adjustments as required on shutters.

M. Receivers ..... 2 Hours

1. Describe the construction of a receiver.
2. List three functions of a receiver tank.

N. Drier-Filter ..... 2 Hours

1. Describe the construction of a drier-filter.
2. List three purposes of the drier.
3. Describe the operation of a drier and diagnose a faulty drier-filter.
4. Describe the installation procedure and location of a drier-filter in a system.

O. Moisture Indicators ..... 1 Hour

1. Describe the purpose, construction and operation of a moisture indicator.

P. Heat Exchanger ..... 2 Hours

1. Explain the purpose of the heat exchanger.
2. Trace refrigerant vapour and liquid flow through a heat exchanger.
3. Recognize the construction of a heat exchanger.
4. Explain how the heat exchanger improves the capacity of a unit.
5. Diagnose and replace a faulty heat exchanger.

Q. Refrigerant Metering Devices ..... 10 Hours

1. State the purpose for the controls.
2. Locate the flow controls in a system.
3. Identify the types of control used in a system:
   a) thermostatic expansion valves
   b) capillary tubes
   c) internally equalizing
   d) externally equalizing
   e) orifice tube system
   f) quench valve
4. Explain the operation of each type.
5. Recognize the purpose of specially charged thermal bulbs.
6. State the purpose of superheat as it applies to the expansion valve.
7. Test expansion valve superheat.
8. Diagnose an incorrectly operating expansion valve.
   a) flooding the evaporator
   b) starving the evaporator
9. Replace faulty valves using the correct size of expansion valve for a system.
10. Describe the effect an incorrect valve will have on a system.

R. Evaporators ..... 2 Hours

1. Explain the purpose of an evaporator.
2. List the different classifications of evaporators.
3. Describe the construction of an evaporator.
4. Explain how distributors are used to avoid excessive pressure drops in a system.

5. Diagnose a faulty evaporator coil or distributor tube.
6. Describe the airflow through an evaporator including design and use of fans.
7. Describe items that affect evaporator performance and how to correct it.

S. Accumulators ..... 2 Hours

1. Describe the purpose of an accumulator.
2. Describe the operation of an accumulator.
3. Recognize the methods used to provide heat for the accumulator.
4. Describe methods of oil return.

T. Vibration Absorbers ..... 2 Hours

1. Describe the purpose of vibrasorbers.
2. Recognize the construction of the suction and discharge vibrasorbers.
3. Describe safety precautions when servicing and replacing a suction or discharge vibrasorber.
4. Describe the purpose of using vibration pads and springs.

U. Service Valves ..... 2 Hours

1. Explain the purpose of service valves.
2. Identify the types of service valves used:
   a) schrader
   b) stem
3. Describe the procedures required when using each type of service valve.

V. Suction Throttling Valves ..... 4 Hours

1. Explain the purpose of a suction-throttling valve:
   a) evaporator pressure regulator
   b) crankcase pressure regulator
2. Locate the suction throttling valve in the refrigeration piping.
3. Identify the types of suction throttling valves.
4. Describe the construction and operation of the valves listed.
5. Test and explain the steps to follow in adjusting the suction pressure.
6. Diagnose and replace faulty suction throttling valves.
7. Service a suction throttling valve removed from the unit (Thermo-King).

W. Safety Release Devices ..... 3 Hours

1. Explain the purpose of the pressure safety release valves.
2. Recognize the two types of pressure release devices used:
   a) blow-off
   b) fusible plugs
   c) rupture disc

X. Basic Thermostat Operation ..... 11 Hours

1. Describe the control functions of a basic thermostat.
2. Understand the terminology used with controls of a basic thermostat operation.
3. Understand the operating principles of mechanical thermostats:
   a) solid state
   b) microprocessor
4. Explain the operating principles and fundamentals of various microprocessors in the industry.

Y. Refrigeration and Heating Cycles ..... 18 Hours

1. Understand the refrigeration and heating cycles for superheat and sub-cooling using:
   a) 3-way valve and pilot solenoid
   b) solenoid flow control system
   c) modulation valves
   d) electronic throttling valves
2. From a diagram provided, trace the refrigerant flow in the cooling and heating cycle of units using the above.
3. Test a 3-way valve and pilot solenoid for operation.
4. Service a 3-way valve removed from the unit.
5. Explain the steps to follow in servicing a 3-way valve installed in the unit.
6. Test flow control solenoids.
7. Service a flow control solenoid removed from the unit.
8. Explain the steps to follow in servicing a flow control valve installed in the unit.
9. Demonstrate master check procedures to evaluate unit condition.

Z. Safety Switches ..... 4 Hours

1. Describe the purpose of safety switches.
2. Understand the operation of safety switches.
3. Be able to locate the following in a system:
   a) high pressure cut-out
   b) high engine temperature
   c) low engine oil pressure
   d) low compressor oil pressure
   e) low pressure cut-outs
   f) high condenser temperature
   g) low level cut-outs
   h) electrical overloads
   i) fan motors
4. Understand the basic safety circuits to aid in diagnosing an engine shutdown.

AA. Test Instruments ..... 8 Hours

1. Using the correct terminology, identify and explain the function of the various measuring tools and test equipment common to the industry:
   a) hydrometers
   b) thermometers
   c) pyschrometer
   d) fluid flow meters
   e) gaseous flow meters
   f) gauge manifolds
   g) charging apparatus
   h) pressure and vacuum gauges
   i) micron gauge
   j) magna helium
   k) new product updates
2. Demonstrate the correct methods for using various measuring tools common to the industry to the desired degree of accuracy, both imperial and metric.
3. Demonstrate the correct method of using and interpreting the various testing and measuring equipment common in the industry.
4. Explain the correct procedures for the care, handling and storage of the various measuring and testing equipment common to the industry.

AB. Leak Testing ..... 2 Hours

1. Demonstrate the two methods of leak detection and correct any leaks as necessary:
   a) electronic
   b) bubble test
2. Demonstrate the use of nitrogen and trace substance for leak detection.

AC. Moisture in a System and Its Effects ..... 7 Hours

1. Explain the problems that can develop due to water contamination:
   a) air
   b) rust
   c) sludge
   d) acid formation
   e) freezing in orifices
2. Demonstrate and describe procedures used to remove moisture from a system:
   a) dryers
   b) compressor oil change
   c) nitrogen
3. Demonstrate and describe steps required for cleaning a severely contaminated system:
   a) scrubbers
   b) flushing
   c) compressor oil change
   d) nitrogen purge
   e) compressor oil filters
4. Explain the term "hygroscopic" and what effect it has on a refrigeration system.

AD. System Recharging .....15 Hours

1. Demonstrate and list the 6 steps to charge a system:
    a) liquid
    b) vapour
    c) partial charge
2. Explain the purpose and operation involved in each step.
3. Demonstrate reclaim, recycle, reuse and recovery.
4. Use the correct refrigerant type and take precautions not to overcharge a system.

AE. Multiplex Systems and Accessories.....6 Hours

1. Identify and describe the operating principles and applications of multiple evaporator systems for:
    a) single temperature
    b) dual temperature
        i) directional air
    c) three temperature
2. Explain the fundamental differences between single and multiple evaporator systems.
3. Identify the evaporator assembly accessories and establish the fundamentals of operation of each:
    a) metering devices
    b) evaporator pressure regulators systems
    c) distributors
4. Identify and describe the operating principles and applications of multiple compressor systems.
5. Establish factors influencing compressor selection for:
    a) low temperature
    b) medium temperature
    c) high temperature
6. Explain the differences between single and multiple compressor systems.
7. Identify and describe the operating principles and applications of multiple compressor systems.

AF. Pressure Enthalpy Diagrams and Psychometry (Appreciation Coverage Only).....8 Hours

1. Describe the meaning of the various lines, curves and numbers found on enthalpy charts and indicate their function.
2. With the aid of charts and information supplied, plot a complete cycle on an enthalpy chart and list all the information derived from the plot.
3. Define net refrigeration effect.
4. With test equipment and a unit available obtain all necessary information to plot and calculate for a unit evaluation on an enthalpy chart.
5. Define psychometry.
6. Describe the meaning of the various lines, curves and numbers found on psychometric charts and indicate their function and uses.
7. Understand the properties of air, apparatus dewpoints and sensible heat factor in relation to the design and operating systems for practical value.

8. Demonstrate the procedure to plot and obtain information from a psychometric chart when only two atmospheric conditions are known.
9. Demonstrate the procedure to evaluate the performance of a unit by the psychometric method.

AG. Insulation and Seals.....2 Hours

1. Describe the purpose of insulation and seals.
2. Understand insulation characteristics.
3. Explain the need of insulation as it applies to the industry.
4. Understand the need for control of air infiltration of the refrigerated unit.

AH. Loading.....2 Hours

1. Describe the need for correct trailer loading techniques.
2. Understand the need for proper air circulation.
3. Understand the need of bulkheads for multi-temperature hauling.
4. Identify product temperature when loading, heat removal and temperature stabilization for various temperatures and load conditions.

AI. Food Preservation (Appreciation Coverage Only) .....2 Hours

1. Describe the principles and methods of food preservation.
2. State the methods, conditions and precautions necessary to provide food preservation under cool storage and transit conditions.
3. Describe freezing methods.
4. Understand the importance of stable temperatures.
5. Describe storage conditions required for fresh meat including:
   a) temperature requirements
   b) shrinkage and humidity
   c) aging and tenderizing
   d) importance of sanitation
6. Be familiar with storage temperatures for dairy products.
7. Use product temperature charts to state the various transit and storage temperatures required for various products.
8. Use charts and forms to calculate heat removal in BTU/h and time required for the pre-cooling, heat removal and temperature stabilization for various temperature and load conditions.
9. Demonstrate trailer cleanliness and know the importance of sanitation.

AJ. Refrigeration Load Calculations.....2 Hours

1. Demonstrate knowledge regarding heat transfer.
2. Identify and calculate wall gain with the factors listed:
   a) conductivity factor
   b) overall conductance
   c) transmission factors
   d) colour
3. Use various manufacturers' forms for load estimating.

4. Identify and calculate infiltration loads.
5. Identify and calculate product loads:
   a) sensible
   b) latent
   c) heat of respiration
6. Calculate the total load of a unit including a load safety factor.

SECTION FIVE:.....PREVENTIVE MAINTENANCE.....30 HOURS

A. Petroleum Products.....4 Hours

1. Describe the functions of oil.
2. Diagnose and correct any visible leaks.
3. Recognize the different grades and types of oil.
4. Describe the use of lubricating oil and additives.
5. Define the following:
   a) viscosity
   b) viscosity index
   c) pour point
   d) inhibitors
   e) detergents
   f) dispersants
   g) S.A.E.
   h) A.P.I.
6. Describe characteristics of:
   a) single viscosity
   b) multi viscosity
7. Describe the use of an oil analysis as a diagnostic tool.

B. Fuels and Additives.....2 Hours

1. Interpret fuel specifications.
2. Diagnose and correct any visible leaks.
3. List the common additives and their purpose in diesel fuel.

C. Lubricating Systems.....2 Hours

1. Describe the two basic lubrication systems:
   a) splash
   b) pressure
2. Diagnose and correct any visible leaks.

D. Lubricating Filtering Systems.....2 Hours

1. Describe the full flow, shunt and by-pass filter systems.
2. Demonstrate servicing filtering systems.
3. Diagnose and correct any visible leaks.

E. Fuel Filtering Systems ..... 2 Hours

1. Describe the construction of each type of fuel filter and give the location in a fuel system of each type.
2. Describe test methods and interpretation of fuel flow.
3. Demonstrate service procedures and precautions.
4. Demonstrate filling and bleeding procedures.
5. Diagnose and correct any visible leaks.
6. Describe the construction requirements of tanks.
7. Demonstrate tank mounting methods and describe necessary precautions.
8. Recognize and describe the function of:
   a) screens
   b) check valves
   c) lines
   d) breathers
   e) selector valves

F. Air Filtering Systems ..... 2 Hours

1. Recognize and describe the function of air filtering systems:
   a) oil bath
   b) dry
   c) air indicators
2. Diagnose and correct any leaks in the system.

G. Electrical Systems ..... 2 Hours

1. Inspect, test and service batteries and connections.
2. Inspect charging and starting circuits.
3. Describe hazards when checking and charging batteries.
4. Describe battery polarity including boosting procedures and precautions.
5. Inspect and correct faulty indicator lights as necessary.
6. Identify and diagnose faulty temperature control devices.
7. Identify electrostatic discharge and determine corrections.

H. Unit Service ..... 8 Hours

1. Diagnose and correct engine leaks as necessary.
2. Inspect and maintain component security.
3. Adjust and set engine R.P.M. to manufacturer's specifications.
4. Locate, diagnose and report any unusual engine noises or conditions:
   a) visible leaks
   b) refrigerant charge
   c) compressor condition
5. Diagnose and correct any visible refrigeration equipment leaks.
6. Inspect the refrigerant charge and correct as necessary.

7. Inspect and report on any abnormal compressor conditions.
8. Identify types of bearings used on fan shafts.
9. Establish maintenance procedures for bearings.
10. Demonstrate proper removal and replacement procedures for bearings.
11. Describe the function of idlers.
12. Identify and establish maintenance procedures for idlers.
13. Demonstrate proper removal and replacement procedures for idlers.
14. Inspect, adjust and replace belts as necessary.
15. Demonstrate proper disposal and recycle of:
    a) oil
    b) antifreeze
    c) filters
    d) batteries
    e) etc.

I. Cooling Systems ..... 4 Hours

1. Describe the functions of the cooling systems:
    a) control engine temperature
    b) remove excess heat
2. Describe the physical principles involved in the operation of the liquid cooling system.
3. Inspect hoses and clamps to determine if replacement is necessary.
4. Properly test a thermostat and describe designs and functions.
5. Describe the operation and testing of temperature and pressure indicators.
6. Describe the relation of vacuum and pressure to a cooling system operation.
7. Explain the function of coolant in the cooling system.
8. Explain the properties of different coolants:
    a) glycol base antifreeze
    b) mixture strength
    c) extended life
9. Test a pressure cap and determine if okay.
10. Demonstrate the proper procedure for reverse flushing:
    a) engine
    b) radiator

J. Business Systems ..... 2 Hours

1. Describe business and trade related practices involving:
    a) shop calculations
    b) warranty forms and describe failure as per manufacturer's information and recommendations
2. Recognize the value of records and reports.
3. Write and understand the importance of a properly written work order.

SECOND PERIOD TECHNICAL TRAINING
TRANSPORT REFRIGERATION TECHNICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

Due to the nature of the work of the Transport Refrigeration Technician, it is imperative that safety be taught on a continuous basis throughout the entirety of this course.
Special emphasis should be placed on weak areas of theory and lab that are evident from progressive tests and examinations administered throughout the course. The time required for such examinations and testing shall be allowed for in each area of instruction.

SECTION ONE:..... REFRIGERATION..... 30 HOURS

A. Review of Basic Systems .....30 Hours

1. Describe the basic principles of refrigeration learned in first period.
2. Identify the types of compressors, the method of lubrication and the procedure to calculate displacement and compression ratios.
3. Identify the method of controlling the flow of refrigerant and the components necessary to change the mode of operation.
4. Identify the type of condenser and method of heat rejection.
5. Describe the operation of a heat exchanger and how if affects capacity.
6. Identify the methods of metering the flow of refrigerant to the evaporator and characteristics of the various controls.
7. Recognize the different evaporator designs and their characteristics.
8. Explain the function of an accumulator tank, the method of removing oil and reason some units do not require an accumulator.
9. Recognize the safety procedures required when working with refrigerants and explain the pressure temperature relationship of the various refrigerants.
10. Identify the state of the refrigerants as it travels through the various components in the system.
11. State and measure the pressure and temperature expected at the various components under different mode conditions.
12. Identify the components that can be replaced by performing a pump down versus a complete evacuation of the system.
13. Demonstrate the procedure to remove all of the refrigerant from a system including recycle, reclaim and reuse.
14. List the safety precautions to follow when adding refrigerant to a system.
15. Explain the methods of determining when a system is free of air and contaminants.
16. Demonstrate the procedure to evacuate air and contaminants.
17. State the results of not removing air and contaminants from the system.
18. Describe the effects of moisture or acids on the operation of a unit.
19. Explain and demonstrate the procedures to determine the condition of a unit using the master check method.
20. List the components that can be checked when doing a master check.
21. Demonstrate the procedure for doing master checks on units common in the industry.

22. Describe the conditions expected when diagnosing a starving evaporator.

23. Describe the conditions expected when diagnosing a flooded evaporator.

SECTION TWO: ..... DIRECT CURRENT AND RELATED MATHEMATICS ..... 50 HOURS

A. A. Direct Current ..... 50 Hours

1. Explain the fundamental relationship between the structure of the atom and the flow of electrons.
2. Define quantity, express symbols and units of measurement for the following electrical terms:
   a) Volts
   b) Amperes
   c) Ohms
   d) Watts
   e) Watt-hours
   f) Coulombs
   g) Joules
3. Using Ohm's Law describe the relationship of voltage, current and resistance in an electric circuit.
4. Solve problems using Ohm's Law.
5. Connect circuits and make voltage, current and resistance measurements to verify Ohm's Law.
6. Analyze and explain series, parallel and series-parallel circuits and identify their applications.
7. Connect and take measurements of series and parallel circuits using schematic and wiring diagrams to verify Ohm's Law.
8. Define Kirchoff's Laws.
9. Apply Kirchoff's current and voltage laws to a circuit.
10. Define conductor with reference to electricity.
11. Define resistivity.
12. Explain factors that affect the resistance of conductors.
13. Define insulators with reference to electricity.
14. Define the prefixes listed:
    a) Mega
    b) Kilo
    c) Milli
    d) Micro
15. Describe the proper care and safety precaution for ammeters, ohmmeters and voltmeters.
16. Demonstrate accurate measurements using a voltmeter, ohmmeter and ammeter.
17. Demonstrate proper scale selection and wire connections for voltmeters, ammeters and ohmmeters:
    a) diodes
    b) transistors
    c) basic solid state components-circuits
18. Identify and locate diodes and transistors (uses) in the electrical circuitry of the standard components.
19. Describe the function of diodes and transistors.

20. Test and identify faulty diodes and transistors.
21. Explain different applications of diodes including:
    a) as a switch
    b) as a relay
    c) rectifiers
        i) single phase
        ii) three phase
22. Describe the function, location and construction of a capacitor.
23. Identify the circuits containing capacitors.
24. Identify the components in a solid-state circuit.
25. Describe the operation and function of the components in a solid-state circuit.
26. Identify the loads controlled by the solid-state circuits.
27. When provided with a fault, diagnose the problem utilizing wiring diagrams and test equipment:
    a) open
    b) shorts
    c) grounds
28. Describe the importance of heat dissipation in electrical circuits.
29. Describe the characteristics of magnetic lines of force:
    a) magnetic fields and lines of force
    b) magnetic attraction and repulsion
    c) electromagnetic induction
    d) self-induction
30. State the laws of magnetic attraction and repulsion.
31. Describe the field around a current carrying conductor.
32. Describe electromagnetism.
33. Describe the self-induction in a coil.
34. Understand the methods used to generate ac and dc.
35. Describe the relationship between cycles, poles and frequency.
36. Recognize the basic construction of a transformer:
    a) basic construction
    b) theory of operation
    c) voltage ratio/current ratio/turns
37. Understand the theory of operation of transformers.
38. Describe and solve problems involving transformer voltage, turns and current ratio.
39. List the losses that occur in a transformer.
40. Demonstrate safe working practices during all phases of practical assignments.

SECTION THREE: ..... ELECTRICAL COMPONENTS ..... 44 HOURS

A. Electrical Components ..... 44 Hours

1. Describe battery:
   a) construction in detail
   b) sizes and capacities
   c) handling and safety
   d) maintenance and testing
   e) charging procedures and precautions
   f) multiple battery circuits
2. Describe the principles of operation and uses for the types of switches listed:
   a) mechanical (hand operated)
   b) micro
   c) solenoids and relays
3. Describe the operation and location of solenoids (pull rotary):
   a) switch operating
   b) valve operating
   c) door operating
   d) engine controls
4. Explain the operation of glow plugs.
5. Identify the location of each component in the electrical circuitry of a standard unit:
   a) pressure control
      i) high refrigerant pressure cut-out
      ii) refrigerant pressure regulator HP2
      iii) low refrigerant pressure cut-out
      iv) low engine oil pressure cut-out
      v) low compressor oil pressure cut-out
   b) temperature control
      i) high engine temperature
      ii) low engine temperature
   c) electrical
      i) thermal overload
         - manual reset
         - automatic reset
6. Describe the construction and function of the safety switches.
7. Perform adjustment on the switches as necessary.

8. Recognize the following components and their location in the safety circuit:
   a) high engine temperature
   b) low engine oil pressure
   c) high compressor discharge pressure
   d) condenser fan motor overload
   e) low compressor oil pressure
   f) low compressor suction pressure
   g) fuses
   h) circuit breakers
   i) low fuel shutdown
   j) low coolant shutdown
   k) indicator lights
   l) out of range indicator
   m) transducers related to microprocessors
9. Describe the function, construction and location of the engine temperature gauge.
10. Describe the function, construction and location of the engine oil pressure gauge or indicator light.
11. Describe the function, location and construction of an ammeter.
12. Identify the circuit the ammeter is in.
13. Describe the function, location and construction of a compressor suction gauge.
14. Make adjustments to a compressor suction gauge.
15. Describe the function, location and construction of a box temperature thermometer.
16. Make adjustments to a box temperature thermometer.
17. Describe the function, location and construction of a running time meter.
18. Identify indicator lights, out-of-range indicator and pressure transducers related to microprocessors.
19. Explain the function of a thermistor:
   a) thermistor
   b) bimetal
   c) pyrometer thermal couple
20. Locate the temperature sensors in the electrical circuitry.
21. Describe the construction of the sensors.
22. Demonstrate adjustments to the sensors.
23. Describe the function and location of the sensors listed:
   a) low fuel shutdown
   b) low engine coolant shutdown
24. Identify the circuits the sensors are in.
25. Describe the function of a relay-contractor.
26. Recognize their location (uses) in the electrical circuit.
27. Describe the location, circuit, and construction of the thermostats:
   a) mechanical
   b) solid state
   c) micro processors
28. Perform adjustments to the thermostats.

29. Describe the methods of calibrating solid state thermostats.
30. Describe the procedure to test the accuracy of temperature sensors.
31. Explain the operating characteristics of a micro processor.
32. Describe the function and construction of the defrost circuit initiators and recognize their location in the electrical circuitry:
    a) manual
    b) air pressure differential
    c) defrost timer
        i) mechanical
        ii) electrical
        iii) electro-mechanical
33. Perform adjustments as necessary on the defrost circuit initiators.
34. Describe the operation and function of micro processor control system:
    a) sensors used in the system
35. Describe and interpret programming of the system.

SECTION FOUR: ..MECHANICAL GENERATING AND STARTING (CRANKING) SYSTEMS ..... 24 HOURS

A. Mechanical Generating Systems ..... 17 Hours

1. Name the parts of an automotive 12 V dc alternator.
2. List and explain the information found on the alternators nameplate.
3. Explain the principle of operation.
4. Demonstrate the ability to test and diagnose electrical and mechanical faults.
5. Identify different regulator types:
    a) solid state regulation
6. Explain regulation and factors affecting regulation.
7. Describe and demonstrate special testing procedures and precautions relating to regulators and circuits.
8. Describe principles of operation of (high voltage ac gen sets) and function of three phases:
    a) brushless three phase
    b) methods of control
        i) voltage
        ii) current
        iii) cycles
9. Recognize types and capacities of alternators.
10. Follow circuits utilizing diagrams and test equipment.
11. Understand terminology used.
12. Demonstrate inspection and testing procedures.
13. Explain methods of control and factors affecting control.
14. Overhaul an alternator according to manufacturer's procedures.

B. Starting (Cranking) Systems ..... 7 Hours

1. Describe the basic requirements of a starting (cranking) system.
2. Explain the basic function of a starting (cranking) system.
3. Identify the types and designs of starter motors.
4. Explain the operating principles of a simple dc series starting motor.
5. Identify and interpret circuitry variations in different designs of starting motors.
6. Identify and understand the function of all starting motor parts.
7. Diagnose problems utilizing a starter load test.
8. Test an assembled starting motor.
9. Diagnose the malfunctions from the test results.
10. Diagnose and correct the faults found in the tests.
11. Identify the types and designs of starter drives (in service).
12. Describe their basic function and principles of operation.
13. Inspect, clean and test drives.
14. Describe the basic functions of starting aids including:
    a) preheating the intake air

SECTION FIVE: ..... ELECTRICAL CIRCUITS ..... 37 HOURS

A. Electrical Circuits ..... 37 Hours

1. Recognize the components of the other circuits and their location within the circuit.
    a) safety circuits
    b) start circuit
    c) high speed cool circuit
    d) low speed cool circuit
    e) low speed heat circuit
    f) high speed heat circuit
    g) defrost circuit
    h) charging circuit
    i) automatic stop-start circuit
2. When provided with a fault, diagnose and repair the problem utilizing wiring diagrams and test equipment in the correct circuit including:
    a) test continuity of a circuit using a voltmeter
    b) use a voltmeter for locating voltage drops
    c) use an ohmmeter for testing resistance
    d) use an ammeter for testing current draw
    e) test an automatic defrost switch
    f) test and calibrate a Carrier solid state thermostat
    g) test and calibrate a Thermo-King solid state thermostat
3. State the precautions necessary to prevent damage to microprocessors from electrostatic discharge.
4. Demonstrate the procedures to access the operating conditions from the microprocessor.
5. Explain the software revisions and the method to upgrade.

6. Explain the alarm codes and method to clear the codes.
7. Demonstrate the procedure to down load information from the microprocessor to the personal computer.
8. Explain the security levels in some microprocessors.
9. Demonstrate proper testing and diagnosing procedures.

SECTION SIX:.... ELECTRICAL POWER SUPPLY AND ALTERNATING CURRENT THEORY..... 20 HOURS

A. Electrical Power Supply Systems ..... 10 Hours

1. Identify supply system circuits-protection and switching from full load current rating for:
   a) conductors
   b) overcurrent
      i) fuses
      ii) breakers
   c) overloads
2. Describe the function of a ground fault circuit interrupter.
3. Identify the circuit and connections of a ground fault interrupter.
4. Identify and understand the use of the plugs and receptacles listed:
   a) 2 prong old style
   b) "U" ground
   c) crow's foot
   d) direct current
   e) 15 ampere, 250 volt, single phase
   f) 20-30 ampere, 125 or 250 volt, single phase
   g) 20 ampere, 250 or 480 volt, three phase
   h) 50 ampere, 250 volt, three phase
5. Use electrical code tables for corrections when sizing cable:
   a) length vs. size of conductors for
      i) horsepower rating
      ii) voltage in use
      iii) amperage draw
      iv) length of run
6. Define and measure line loss and voltage drop in a circuit.
7. Recognize the proper use of portable tools and the importance of grounding equipment.
8. Identify electrical hazards, safe working techniques and procedures when working with electrical circuits and rotating equipment, including:
   a) proper use of tools
   b) personal protective equipment
   c) lockout and tagging procedures

B. AC Theory..... 10 Hours

1. Describe ac theory:
   a) sine waves
   b) effective values
   c) maximum of peak value
   d) electrical degrees
   e) cycles
2. Define instantaneous value.
3. Define effective value.
4. Define maximum or peak value.
5. Define:
   a) phase
   b) lead
   c) cycle
   d) angles in electrical degrees
6. Describe the mechanical generation of ac current for single and three phase units:
   a) single phase
   b) three phase
7. Define a poly-phase electrical system.
8. Explain the generation of three phase voltages.
9. State the advantages for three phase systems over single phase systems.
10. Name the types of three phase connections.
11. Define the term balanced three phase system.
12. State the phase relationship for the 3 voltages in a three phase system.
13. Describe inductance and the factors which affect inductance.
14. Describe inductance and its effect.
15. Describe the dc inductive effects.
16. Describe the ac inductive effects.
17. Define inductance and state its symbol.
18. State the unit of measurement for inductance and its symbol.
19. Define inductive reactance and state its symbol.
20. State the unit of measurement for inductive reactance and its symbol.
21. Describe the construction and characteristics of an elementary capacitor.
22. Describe capacitance and the factors which affect it.
23. Describe capacitor types and applications.
24. Explain ac capacitive effects.
25. State the unit of measurement for the charge of a capacitor and give its symbol.
26. Define dielectric strength.
27. State the unit measurement for capacitance.
28. Define capacitive reactance.

29. Give the symbol for capacitive reactance and state its unit of measurement.
30. Explain the equation for capacitive reactance.
31. State the phase relationship between voltage and current in a capacitive circuit.
32. Understand the effects of capacitors hooked in series or parallel circuits.
33. Define impedance (appreciation coverage only).
34. State the unit of measure for impedance.
35. State the components of an impedance triangle.
36. Define the ac circuits listed and explain the differences of each:
    a) resistive circuit
    b) inductive circuit
    c) capacitive circuit
37. Describe the advantages of ac over dc.
38. Describe and know the importance of a balanced three-phase system.
39. Describe the effects of unbalanced voltages on a three-phase system.

SECTION SEVEN: ..... ELECTRICAL MOTORS AND TROUBLESHOOTING ..... 35 HOURS

A. Electrical Motors ..... 18 Hours

1. Understand the principles, characteristics and applications of single-phase motors listed:
    a) split phase
    b) capacitor start
    c) permanent (capacitor run)
    d) multi-speed motors
    e) dual voltage
2. Demonstrate connections and draw diagrams for:
    a) single and dual voltage
    b) multiple speed
    c) reversing
    d) current and voltage starting relays
3. Explain protective devices for three phase motors, including:
    a) built-in thermal
    b) current relays
    c) overload relays
4. Identify and describe motor controllers:
    a) manual
    b) magnetic
5. Demonstrate replacement of built-in thermal overload devices for single and dual voltage motors.
6. Demonstrate the following motor conditions:
    a) low voltage
    b) high voltage
    c) overloading
    d) blocked ventilation
    e) single phasing

7. Demonstrate the basic service of a dc motor.
8. Identify and interpret the information contained on a motor data plate.
9. Explain the application of relays to magnetic switches.
10. Explain the principles of a manual and magnetic switch.
11. Understand the operation of the components of a magnetic switch.

B. Electrical Motor Troubleshooting ..... 17 Hours

1. Diagnose the fault of motors that will not start utilizing systematic test procedures and test equipment:
   a) will not start
   b) motor noisy
   c) high temperatures
   d) hot bearings
   e) wound rotor motor troubles
2. Diagnose noisy motors and determine noise fault:
   a) electrical
   b) mechanical
3. Describe and recognize conditions that make a motor operate at above normal temperatures.
4. Correct conditions that make motors operate at higher than normal temperatures.
5. Relate the possible effects of over voltage and under voltage on motors.
6. Recognize and describe why bearings run hotter than normal including:
   a) bushings
   b) ball bearings
7. Demonstrate and understand the importance of full load amps, lock rotor amps and free running amps.
8. Perform tests on other electrical devices associated or related to motors.
9. Utilize a systematic sequence of testing.

THIRD PERIOD TECHNICAL TRAINING
TRANSPORT REFRIGERATION TECHNICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

Due to the nature of the work of the Transport Refrigeration Technician, it is imperative that safety be taught on a continuous basis throughout the entirety of this course.
Special emphasis should be placed on weak areas of theory and lab that are evident from progressive tests and examinations administered throughout the course. The time required for such examinations and testing shall be allowed for in each area of instruction.

SECTION ONE:.....DIESEL ENGINE THEORY, SERVICE AND REPAIR..... 123 HOURS

A. Engine Fundamentals .....15 Hours

1. Explain the stages of development of the internal combustion engine.
2. Explain the principles of operation in relation to:
   a) torque
   b) bore
   c) stroke
   d) engine displacement
   e) compression ratio
3. Identify the different classifications of engines as to:
   a) design of cylinder arrangement
   b) different cooling methods
   c) strokes per cycle (two and four)
   d) valve arrangement and head design
   e) induction method
   f) type of fuel
4. Recognize engine types by manufacturer including:
   a) Izusu
   b) Kubota
   c) Yanmar

B. Measuring tools .....3 Hours

1. Demonstrate the proper use of and explain the limitations of:
   a) rulers
   b) common callipers
   c) small-hole gauges
   d) telescoping gauges
   e) dial indicators in Imperial and SI units
   f) outside and inside micrometers in Imperial and SI
   g) vernier calipers in Imperial and SI units
   h) feeler gauges
   i) weigh scale
2. Demonstrate proper care and storage of precision measuring tools.

3. Explain the use and care of the steel straightedge.
4. Demonstrate the use of protractors and dividers for a given project.

C. Engine Blocks and Liners ..... 12 Hours

1. Identify the different materials used in cylinder blocks:
   a) cast iron
   b) aluminium
2. Explain the purpose of a cylinder block:
   a) serves as a foundation for all engine parts
3. Explain the relationship of materials to heat and friction.
4. State the purpose and identify types of sleeves and liners.
5. Describe the methods of measuring a cylinder for:
   a) taper
   b) out of round
   c) oversize
6. Explain the procedures employed in reconditioning cylinders and liners.
7. Demonstrate removal and replacement procedures.
8. Explain reasons for proper liner positioning.
9. Explain procedures to check journal alignment.

D. Pistons, Piston Rings and Cylinder Liner Service ..... 12 Hours

1. State the materials used in relation to expansion and heat control:
   a) cast iron
   b) aluminum
2. Describe the function of the piston:
   a) transmit thrust
   b) assist in sealing combustion
   c) aid in creating turbulence
   d) dissipate heat
3. Identify and state the function of special piston designs, construction and characteristics:
   a) heat dam
   b) cam ground piston
   c) tapered piston
   d) vertical slot
   e) horizontal slots
   f) slipper piston
   g) knurling
4. Describe the relation of pistons to reciprocal motion.
5. Describe provisions used for lubrication and cooling.

6. Demonstrate proper measuring techniques with respect to:
   a) accurate piston size
   b) oversize determination
   c) clearances
   d) reconditioning
7. Describe the three pin retaining methods.
8. Describe a proper pin fit for a specified pin.
9. Describe the function of piston rings and their location:
   a) seal combustion and compression
   b) control oil
   c) transfer heat
10. Describe the construction of rings, materials used, and the types of rings used:
   a) rectangular
   b) tapered face
   c) inside bevel
   d) barrel face
   e) step joint
   f) angle joint
   g) butt joint
   h) cast iron
   i) chrome plated
   j) molybdenum
   k) stainless steel
11. Properly install rings onto a piston observing all precautions including:
   a) ring expanders
   b) ring location
   c) lubrication
12. Measure and fit piston rings to piston and cylinder with reference to:
   a) ring to land clearance
   b) end gap
   c) oversize cylinder
13. Identify and properly install segmented or one piece oil rings.
14. Demonstrate installation of the piston into the engine:
   a) proper ring staggering
   b) lubrication
   c) ring compressor
   d) bolt boots
   e) rod torqued to shaft
15. Identify different designs of oil control piston rings.

E. Connecting Rod Fundamentals and Service ..... 10 Hours

1. Explain the function of the connecting rod.
2. State the material and process in manufacture of a connecting rod.
3. Identify the material used in connecting rod bushings.
4. Identify different types of rods by the type of pin.

5. State the pin clearance or interference fit in the eye of the rod.
6. State the materials used in bearing construction:
   a) insert backing material
   b) bearing materials
   c) methods of applying bearing material to the backing
7. Identify methods of lubricating connecting rod bearings:
   a) oil holes in inserts
   b) oil passage drilled in rod
   c) spurt hole in rod
   d) connecting rod throw off oil
8. State seven (7) bearing insert characteristics:
   a) conductivity
   b) fatigue resistance
   c) anti scuffing
   d) conformability
   e) imbedability
   f) load carrying capacity
   g) anti corrosion ability
9. Explain how a bearing is able to dissipate heat quickly.
10. Explain crush and spread and their purpose.
11. Demonstrate the procedure in straightening a rod:
    a) bends
    b) twists
12. Explain how a rod is balanced to the engine.

F. Crankshaft, Bearings, and Related Component Fundamentals and Service.....11 Hours

1. Describe the function of the crankshaft.
2. Distinguish between the designs of different crankshafts for different engine designs.
3. Explain the relationship between firing orders.
4. State the different materials and method of crankshaft manufacture.
5. Name six major crankshaft parts:
   a) main journal
   b) rod journal
   c) counterweight
   d) web
   e) check
   f) oil slinger
6. Inspect and evaluate the condition of the shaft from the standard measurements:
   a) journal size
   b) out of round
   c) taper
   d) thrust bearing surfaces
   e) fillet radius condition
   f) straightness
   g) crack detection

7. Identify different types and designs of crankshaft bearings.
8. Describe crankshaft lubrication provisions:
   a) oil fed to rod throw from main journal
9. Demonstrate proper crankshaft installation, including:
   a) cleanliness
   b) lubrication
   c) thrust bearing protection
   d) plastigage
   e) thrust main alignment
10. Measure a crankshaft for wear, taper, flatness and end play.
11. Understand the principle of magnafluxing.
12. Describe the different means of balancing and relate the different balancing components:
   a) flywheel
   b) vibration dampers
   c) rotating balance weights
   d) crankshaft counterweights
   e) engine balance and components that affect engine balance
13. Demonstrate proper removal and installation procedures of a harmonic balancer.
14. Recognize different designs of dampers and counterweights.

G. Camshaft and Follower Fundamentals and Service ..... 11 Hours

1. Describe the functions of the camshaft:
   a) speed relationship to crankshaft
   b) opens valves and determines closing rate
2. Contrast the design features of "in block" or "overhead" design.
3. Define and relate camshaft construction terminology (cam and lobe name parts).
4. Describe the camshaft relationship to crankshaft.
5. Describe the use of the cam as a drive:
   a) oil pump
   b) fuel pump
6. Describe how the camshaft bearings and lobes are lubricated.
7. Describe camshaft relationship to engine performance.
8. Interpret a valve timing diagram:
   a) lead
   b) lag
   c) overlap
   d) duration
9. Recognize a worn cam lobe:
   a) by visual inspection
   b) by measurement
10. Measure a camshaft journal for wear.
11. Diagnose badly worn cam bearings by an oil pressure loss.

12. Demonstrate the proper removal and installation of cam bearings.
13. State the interaction of the cam lobe with the lifter base and the design features built in.
14. Measure to determine if a lifter is worn out:
    a) refacing and reseating measurement precautions and methods
    b) reconditioning rocker arms

H. Valve Train Fundamentals And Service ..... 13 Hours

1. Describe the operation of several different valve trains:
    a) overhead valves
    b) overhead cam
    c) dual overhead cam (awareness)
2. Describe the function and adjustment of the valves.
3. Describe the function of guides and the different types of guides.
4. Describe the function and action of a release type or positive type rotator.
5. Recognize and describe the function of springs and retainers and spring adjustment.
6. Describe the function of valve seals.
7. Demonstrate installation of valve seals:
    a) different lengths, inlet and exhaust
    b) special protectors
    c) positive seals
    d) O ring types
8. Describe the relationship of valve design to engine design.
9. Describe the heat transfer method employed by the valve and state clearance differences between inlet and exhaust due to heat:
    a) guide
    b) valve lash
10. Demonstrate valve removal and reconditioning methods:
    a) proper use of a spring compressor
    b) deburring the valve stem
    c) stem wear
    d) refacing
    e) recondition stem end
    f) inspection
11. Describe and demonstrate the method of replacing the guide or the seat on a common centre.
12. Perform a series of tests to determine if a valve spring is still good and know the importance of valve spring tension and proper installation.
13. Describe different methods of lubricating the valve train:
    a) camshaft metering
    b) restricted oil flow
    c) push rod oiling
14. Describe the relationship of valve timing to engine performance.

I. Cylinder Head Fundamentals and Service ..... 13 Hours

1. State the function of a cylinder head.
2. Recognize the materials a head is made of:
   - a) cast iron
   - b) aluminum
3. State the purpose in different combustion chamber designs.
4. Discuss construction characteristics in cylinder head design:
   - a) coolant passages
   - b) coolant nozzles
   - c) inlet and exhaust ports
5. Demonstrate removal procedures and precautions:
   - a) engine cool
   - b) properly drained
   - c) loosening sequence
   - d) proper storage
6. Demonstrate proper testing procedure for head:
   - a) cracks
     - i) visual inspection
     - ii) magnetic particle
     - iii) dye check
     - iv) pressure check
   - b) warpage
     - i) straight edge
   - c) stoppages
   - d) damage to combustion chambers
7. Recognize the reason for valve failure:
   - a) worn valve guide
   - b) fatigue failure
   - c) heat failure
   - d) erosion
   - e) preignition
   - f) insufficient tappet clearance
   - g) deposit on seat
   - h) valve seat distortion
8. Properly take measurements pertaining to the following:
   - a) inside guide diameter
   - b) guide protrusion
   - c) diameter of valve stem
   - d) width of valve seat
   - e) margin width
9. Describe the proper removal and installation of valve seat inserts.

10. Properly assemble the cylinder head with reference to:
    a) cleaning of cuttings and grindings
    b) lubrication
    c) correct installation of valves
    d) correct installation of stem seals
11. Properly install the head gasket with regard for:
    a) front and top of gasket
    b) gasket positioning
    c) use of a sealer
    d) block and head surface condition
12. Torque the head in the proper sequence and stages.

J. Combustion Chamber Fundamentals and Service ..... 10 Hours

1. State the purpose of the combustion chamber.
2. Recognize and state the function of:
    a) open combustion chamber
    b) pre combustion chamber
3. Describe the application of:
    a) open combustion chamber
    b) pre combustion chamber
4. Demonstrate removal and installation techniques involved with pre combustion chambers.

K. Oil Pump Fundamentals and Service ..... 13 Hours

1. Describe the designs and function of oil pumps.
2. Describe the operation of oil pumps:
    a) rotor
    b) gear
3. Test and diagnose oil pump failures and demonstrate reconditioning procedures.
4. Describe the operation of the lubrication system valving:
    a) pressure relief valve
    b) pressure regulator valve
    c) pressure differential, filter bypass valve
5. Describe the function and operation of pressure indicators.
6. Diagnose the causes of:
    a) low oil pressure
    b) high oil pressure

SECTION TWO: ..... INDUCTION, EMISSION AND EXHAUST SYSTEMS ..... 10 HOURS

A. Induction Systems ..... 3 Hours

1. Recognize a naturally aspirated engine:
   a) naturally aspirated
   b) supercharged (appreciation coverage only)
   c) air cleaners
2. Describe the function of the intake manifold.
3. Describe different styles of intake manifolds with regard to:
   a) engine design
   b) performance
4. Recognize the relationship of air flow to manifold design.
5. Demonstrate installation procedures of a manifold.
6. Diagnose an engine problem resulting from a leak in the induction system.
7. Describe the designs, styles and function of an air cleaner.
8. Describe the types and operation of each type:
   a) centrifugal or inertia
   b) dry
   c) oil bath
   d) impingement (including self cleaning types)
9. Demonstrate proper maintenance procedures for each air cleaner.
10. Describe styles and operation of precleaners.
11. Demonstrate proper maintenance procedures for precleaners.

B. Emission Control Systems ..... 4 Hours

1. State the basic problems with and the control of:
   a) oxides of nitrogen
   b) carbon monoxide
   c) hydrocarbons
   d) particulants
2. Describe the operation of the ventilation systems.
3. Describe the purpose and necessity of the crankcase ventilation valve.

C. Exhaust Systems ..... 3 Hours

1. Describe the function of the exhaust system.
2. Note the desired design characteristics and relate these to engine performance.
3. Recognize the use of mufflers and resonators in the system.
4. Demonstrate proper removal and installation procedures.
5. Recognize the need for insulators, isolators, and expansion devices as part of the installation.
6. Explain and demonstrate the need for venting the exhaust system to the outside.
7. Test engine exhaust backpressure.

8. Test exhaust temperature with a pyrometer.

SECTION THREE: .....FUEL SYSTEMS (COMPRESSION IGNITION)..... 45 HOURS

A. Transfer Pumps ..... 2 Hours

1. Identify the styles and types of transfer pumps.
2. Describe their function and principles of operation.
3. Recognize the characteristics of construction.
4. Demonstrate diagnosing and testing methods.
5. Demonstrate removal and installation procedures and precautions.

B. Basic Fuel Injection System ..... 5 Hours

1. Describe the demand requirements of an injection system.
2. Describe the basic layout of an injection system including:
   a) tank
   b) lines
   c) pump
   d) nozzles
3. Recognize all components of a system and describe their function.
4. Describe the function and operation of an automatic timing advance.

C. Port and Helix and Rotory Metering Systems ..... 20 Hours

1. Describe principle of operation:
   a) port and helix
   b) rotory
2. Describe the basic characteristics of port and helix metering systems.
3. Describe construction of these systems.
4. Perform minor adjustments.
5. Recognize applications of these systems.
6. Demonstrate inspection and diagnosis procedures.
7. Recognize crankcase fuel dilution and correct causes.

D. Mechanical Injection Fuel Systems (Identification by Manufacturer) ..... 8 Hours

1. Identify each of these systems:
   a) Bosch, inline, rotory
   b) Diesel kiki inline
   c) Denso inline
   d) Zexel rotory
2. Recognize design variations and applications.
3. Demonstrate adjusting and timing procedures.
4. Describe and demonstrate removal and installation precautions.
5. Demonstrate inspection and diagnosis procedures for pumps.

6. Describe the function and operation of injection lines and injectors.
7. Demonstrate testing and adjusting injectors.
8. Demonstrate removal and replacement of injectors; describe procedures and precautions.
9. Demonstrate filling and bleeding procedures.
10. Describe lubrication provisions.
11. Demonstrate the sequence of system testing.

E. Governors.....4 Hours

1. Recognize the different types and designs of governors:
   a) mechanical
2. Describe the function of a governor and limitations.
3. Describe the principles of operation.
4. Define governor terminology and its application (i.e. response, stability, sensitivity, droop, etc.).
5. Describe inherent characteristics of specific types.
6. Diagnose problems in terms of type and function.
7. Demonstrate and describe adjustment limitations to each type.
8. Describe and ensure adequate lubrication provisions for a governor.
9. Make minor repairs and adjustment.

F. Engine Testing and Adjusting to Manufacturer's Specifications.....5 Hours

1. Describe and demonstrate preparation procedures.
2. Demonstrate start up procedures and precautions.
3. Demonstrate run-up and test procedures using all test equipment.
4. Recognize and interpret incorrect operating conditions (i.e. smoking, loss of power, low rpm, excessive noise, etc.).
5. Demonstrate corrective action and procedures for incorrect operation.
6. Demonstrate shutdown precautions after completion of tests and tune-up.

G. Special Conditions .....1 Hour

1. Describe the effect altitude has on engine tune and performance.
2. Describe the effect of severe weather conditions on engine running, starting and performance.

SECTION FOUR: .....REFRIGERANT COMPRESSORS..... 35 HOURS

A. Compressors.....35 Hours

1. Identify the types of compressors used in the industry mechanically driven and semi-hermetic:
   a) screw
   b) Scroll
   c) reciprocating
   d) rotary vane
2. Describe the valve arrangements and action in compressors.

3. List methods of capacity control and explain the purpose of the compressor capacity control devices.
4. Identify the parts of a compressor.
5. Trace refrigerant flow through a compressor.
6. Describe capacity and calculate capacity of a compressor.
7. Describe the function of the compressor in the system and its basic principles and general operation.
8. Describe the cooling and lubrication provisions for the types of compressors.
9. Perform an efficiency check and recognize and record all malfunctions.
10. Demonstrate proper diagnosis and testing procedures for malfunctions.
11. Demonstrate reconditioning procedures and precautions.
12. Calculate the displacement and capacities of compressors.
13. Identify direction of rotation for lubrication:
    a) importance
    b) valving
14. Describe the function of a compressor shaft seal.
15. Replace leaking compressor shaft seals.

SECTION FIVE: .....AUXILIARY HEATING SYSTEMS..... 27 HOURS

A. Heating Systems.....27 Hours

1. Describe construction and operating principles of catalytic heaters.
2. Describe safety precautions when lighting, servicing and installing including:
    a) lines and connections as per code
3. Demonstrate testing procedures and precautions.
4. Demonstrate specific precautions in:
    a) handling
    b) storage
    c) utilization
5. Describe principles of operation of a storage tank.
6. Describe where a storage tank for L.P.G. should be located and security precautions.
7. Describe the capacity and maximum filling level of a L.P.G. tank.
8. Advise that a filling certificate is available.
9. Describe the function of regulators.
10. Perform regulator adjustments and describe adjustment limitations.
11. Demonstrate servicing requirements as necessary.

B. Workplace Coaching Skills.....0 Hours

1. Describe the following coaching skills used for training apprentices:
   a) identify the point of the lesson
   b) link the lesson
   c) demonstrate the lesson
   d) provide an opportunity to practice a skill
   e) give feedback to the learner
   f) assess the learner's progress

Excellence through training and experience

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